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EFFECT OF REMOVAL OF THE VIRGIN WHITE PINE STAND UPON THE PHYSICAL FACTORS OF SITE

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It has long been a matter of speculation to what extent the complete or partial removal of the dense virgin timber alters the air and soil temperature in relation to humidity, soil moisture, and evaporation. Information on this subject would be of value in explaining the survival and growth of seedlings under different conditions, and might also be of use in a study of invasion or succession of vegetation after cutting and in fire protection. In order to secure such data, therefore, the U. S. Forest Service on July 12, 1919, installed three meteorological stations near the Priest River Forest Experiment Station in northern Idaho.

Since it was possible to keep the records at these stations for only a limited period, July and August, the months which are the hottest and most critical part of the growing season, were selected. Much credit is due Mr. Herman Bauman, Forest Service Field Assistant in 1919, for his conscientious care and painstaking accuracy in obtaining the records.

The stations were installed on the Binkly sale area, near the Priest River Forest Experiment Station. Station A was located on land cut clear in 1909–1910, about 250 feet south from the edge of the 300-year-old western white pine stand. On this site there are a few down logs and stumps, and practically no forest reproduction and no trees. Station B was placed about 400 feet north well within the tract logged in 1918, where there were several large western hemlocks and western red cedars, which are usually associated with white pine and made about one third forest cover. There was considerable unburned slash on the ground, but none right at the station. Station C was placed well within the uncut virgin timber, at least 300 feet from the opening on the south side.

Each station was equipped with maximum and minimum air thermometers of the Weather Bureau pattern, and Stations A and C had air thermographs and soil thermographs. These instruments were placed 4½ feet above the ground within a box made of half-inch board, painted white on the outside, and open to the north. At each station there was one psychrometer and one Livingston porous cup cylindrical atmometer. The latter was placed 6 inches above the ground; the bottle containing the water was placed entirely below the surface.

Daily soil temperature readings and semi-weekly soil moisture samples were obtained at a depth of 6 inches near each station on a bared plot of ground one meter square away from all roots. The records, except soil samples, were taken at 5 P.M. each day from July 12 to August 31.

A summary of the differences in air and soil temperature, relative humidity, evaporation, and soil moisture is given in the following table, and the averages of the daily thermograph records are shown in figure 1.

TABLE I. *Air temperature, relative humidity, evaporation, soil temperature and soil moisture averaged for each of three periods*

	Air Temperature			Relative Humidity 5 P.M.	Average Daily Evaporation	Soil Temperature at 6″	Soil Moisture at 6″ *	Record
	Max.	Min.	Range					
	°F.	°F.	°F.	Percent	c.c.	°F.	Percent	
Station *A* in the open	90.9	40.1	50.8	21.5	33.6	64.0	31.6	July 13 to 31 inc.
	84.1	41.3	42.8	37.0	45.3	63.4	47.7	August 1 to 15 inc.
	88.1	37.0	51.1	33.5	27.0	62.1	36.9	August 16 to 31 inc
Station *B*, ⅓ forest cover.....	88.8	45.3	43.5	24.0	34.0	60.8	23.5	July 13 to 31 inc.
	81.6	45.4	36.2	39.4	21.0	59.5	28.4	August 1 to 15 inc.
	85.6	42.3	43.3	35.5	25.8	59.5	28.1	August 16 to 31 inc.
Station *C*, full forest cover.....	83.6	47.1	36.5	28.0	19.8	54.1	28.0	July 13 to 31 inc.
	76.3	47.2	29.1	45.5	11.7	55.0	31.4	August 1 to 15 inc.
	81.0	44.2	36.8	32.1	16.5	55.0	32.6	August 16 to 31 inc.

TABLE II. *Summary of records from July 13 to August 31*

Stand Conditions	Air Temperature		Relative Humidity 5 P.M. Per Cent.	Daily Evaporation c.c.	Soil Temperature at 6″ °F.	Soil Moisture at 6″ Per Cent.
	Av. Max. °F.	Av. Min. °F.				
Open....	87.7	39.5	30.7	35.3	63.2	31.6 July 36.7 Aug.
⅓ cover..	85.3	44.3	33.0	26.9	59.9	23.5 July 28.1 Aug.
Uncut...	80.3	46.2	35.0	16.0	54.7	28.0 July 32.6 Aug.

TABLE III. *Average of Air and Soil Thermograph Records for August, Degrees F.*

Location	A.M.					Noon	P.M.					
	2	4	6	8	10	12	2	4	6	8	10	12
Air Temperature in open	42.7	40.4	39.5	50.4	64.5	76.7	82.4	83.3	78.5	61.2	51.0	46.1
Air Temperature in forest	50.7	47.9	46.0	47.6	57.7	67.4	47.1	76.1	73.6	65.9	56.6	53.9
Soil Temperature in open	64.5	64.1	63.3	62.6	61.8	61.4	61.6	62.1	63.1	63.9	64.2	64.4

The air in the uncut forest is about ten degrees warmer than in the open at night, and about ten degrees cooler during the hot part of the day. The curves cross at 7:30 A.M. and 7:30 P.M. for July and August (see fig. 1).

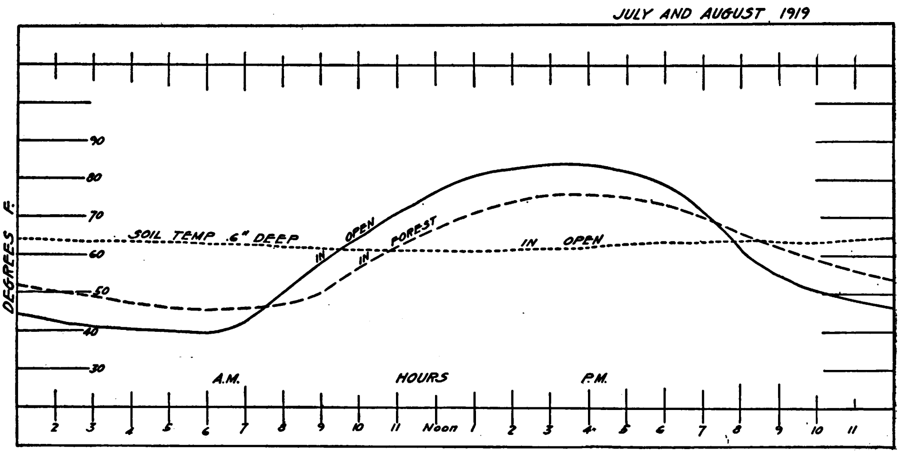

FIG. 1. Showing the influence of the forest in keeping the air temperature cooler in the daytime and warmer at night. Curves, solid and dash, are air temperature

Soil temperatures further show the influence of the forest cover. In the clear-cut area the soil temperature fluctuates 4 and 5 degrees F. between the maxima and minima. The soil thermograph record within the forest shows a variation of only one degree, and the maxima and minima occur from three to four hours later than in the open (see fig. 2).

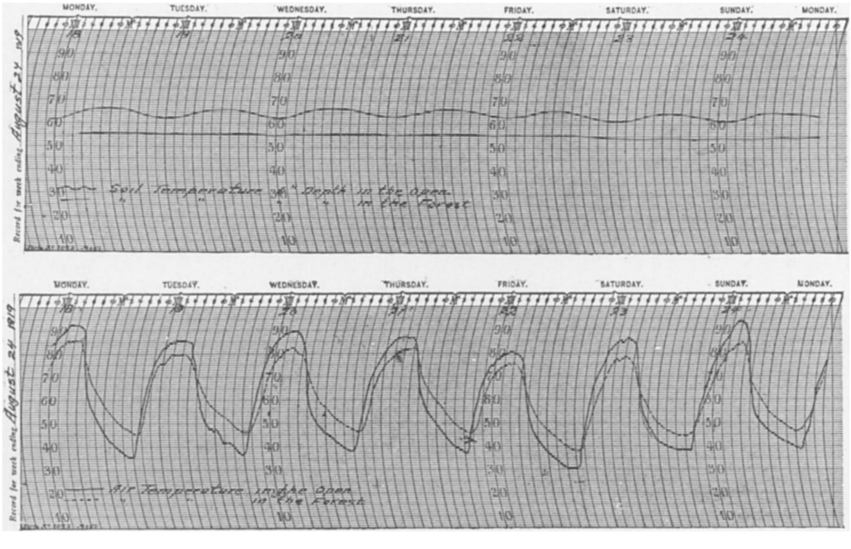

FIG. 2. Thermograph records of soil temperature at 6 inches, above; and of air temperature, below. Soil temperature shows fluctuations in the open, as compared with uniformity under the forest. Air temperature also shows less fluctuation in the forest, with lower maxima and higher minima.

Another matter of interest is that the temperature of the soil in the open reaches the highest point between 12 and 2 o'clock at night, and the lowest point at 2 o'clock in the afternoon. The highest soil temperatures in the forest, on the other hand, occurred at about 4 o'clock in the morning.

Perhaps the difference in evaporation expresses better than any other datum the relative severity of the site. It is more than twice as great in the open as under timber, and on the partly cut area is very close to the average between that of the open and of the forest.

A lower soil moisture under the virgin timber than in the open may seem somewhat of a surprise; yet we must remember that these big trees have their greatest transpiration at this time of the year, and therefore demand much moisture from the soil. Also a considerable amount is intercepted by the crowns. The amount of moisture at any of the stations is not considered too little for white pine seedlings, and the survival of these seedlings on the cut-over area would depend more on whether or not the amount of sunshine or the air temperature were too great, or the rate of transpiration too rapid. In the absence of well-controlled tests on the influence of these factors upon the native coniferous seedlings it it not possible to state anything with finality. However, many of the one-year-old natural white pine seedlings died during the dry and warm months of 1919 on the area where only one third forest cover was maintained.

The complete opening of the site renders it almost totally unfavorable to natural establishment of hemlock and cedar, and somewhat precarious for white pine seedlings. Many of the evergreen plants which usually grow underneath and among the white pine stands, such as *Coptis trifoliata, Cornus canadensis, Pachystima myrsinites, Aralia nudicaulis,* and a great many more tender and moisture-loving plants, among which are *Circaea pacifica, Claytonia perfoliata, Galium borealis,* and *Montia spatulata,* disappear in the clearings. The habitat in the open is more suitable for *Rubus, Lonicera, Linnaea, Spiraea, Sambucus, Ceanothus,* and a great many grasses and sedges which are frequently found in the more open western yellow pine and Douglas fir stands. In the course of eight to ten years the grasses often become altogether too dense for natural reestablishment of the forest.